SAFE AND HEALTHTY FERTILIZER OF ORGANIC WASTE MADE BY ANAEROBIC FERMENTATION

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ABSTRAK

Suatu penelitian untuk menghasilkan pupuk organik melalui fermentasi anaerob limbah organik telah dilakukan di Jakarta Utara, dalam suatu iklim yang cocok untuk berlangsungnya fermentasi tersebut. Bahan baku yang digunakan adalah tinja ayam, tinja babi, tinja sapi, dan eceng gondok + 15% tinja sapi semuanya dalam keadaan segar dan berumur 1-3 hari. Setiap bahan yang difermentasi anaerob selalu diberikan pembanding dengan bahan yang sama, baik jumlah dan mutunya namun tidak difermentasi hanya dibungkus dalam kantong plastik dan ditempatkan berdampingan, masing-masing sebanyak 40 liter volume basah. Untuk mengendalikan pengaruh panas matahari yang datangnya tidak bersamaan terhadap seluruh wadah fermentasi dan perbandingannya, keseluruhan percobaan ditempatkan dalam 3 kelompok (blok) dan pada masing-masing blok, setiap perlakuan ditempatkan secara acak. (Randomized Block Designed). Fermentasi anaerob dilakukan selama 10 bulan. Hasilnya menunjukkan bahwa pupuk organik yang dibuat melalui proses fermentasi anaerob mempunyai nilai yang lebih baik karena kandungan nitrogennya lebih tinggi dibandingkan dengan pupuk organik yang tidak difermentasikan anaerob. Di samping itu banyak patogen yang binasa oleh fermentasi anaerob sehingga potensi penularan penyakit kepada manusia berkurang, yang berarti pula bahwa penggunaan pupuk organik yang telah difermentasi anaerob akan dapat meningkatkan kesehatan lingkungan.

INTRODUCTION

Fertilizers used in agriculture could be devided into two major groups. The first are chemical fertilizers which are usually produced by manufacturing and the second are organic fertilizers which are usually made from agricultural waste, including animal waste. Agricultural waste is also called organic waste or biological waste.

Wide usage of chemical fertilizers in agriculture often causes pollution to the environment especially the inland aquatic ecosystem. For example, water hyacinth is found almost in every stagnant water in Indonesia due to the excess of nitrogen or phospat in water. In Jakarta, this plant invests stagnant water in drains and canals or rivers and often causes flood during rainy season, which is usually followed by the spread of water- borne diseases.

Organic fertilizers from wastes of plant or animals have been commonly practiced for many years in the orient[1)]. Dumping of these materials in an open field for the purpose of composting has caused great danger and hazard to human environment. Many pathogens including microorganisms, fungi and parasites

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can develop normally and even more rapidly in an open dumping area[2]. When a plant receives fertilizers from compost of an open dump, it can also receive the pathogens. Hence, open dump compost create at least two kinds of dangers.

First, during production it can harbour and create many pathogens which could be transmitted to human through water, insect and rodent. Second, by consuming raw vegetables fertilized by open dump compost, it can bring pathogens into human body.

In Indonesia many people are accustomed to consuming vegetables and traditional medicine in raw preparation. This kind of habit surely has a positive impact; it gives vitamins and minerals into the human body, but on the other hand the pathogens in the plant fertilized by open dump compost could possibly get into the body, and can cause infection. So, open dump compost production could also produce diseases by direct infection through water or by vector of insect and rodent.

To overcome the above mentioned problems, the organic fertilizer should be treated in such a way so it does not make a hazard to health. Biotechnology of anaerobic fermentation is one of the many ways to solve this problem. This biotechnology has been proven suitable for eliminating pathogens from wastes of agriculture and human excrement, for some pathogenic agents such as virus, bacteria, parasites and their eggs could be digested deadly in anaerobic fermentation[3].

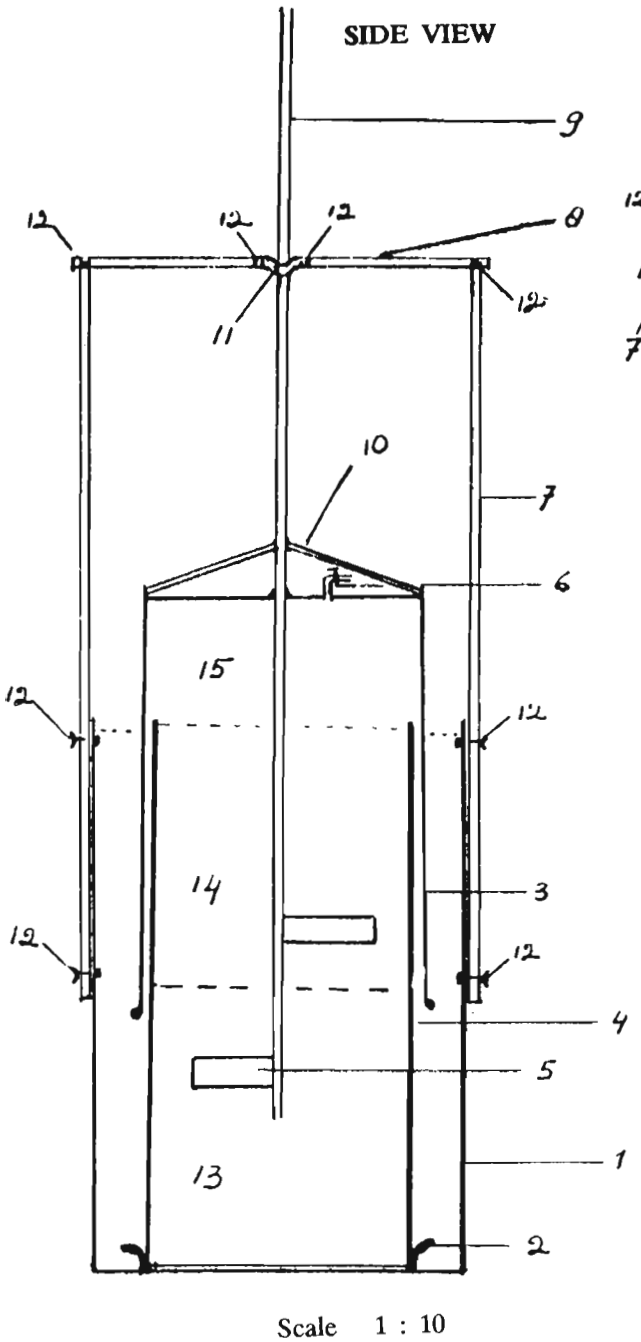
The purpose of this study is to find out a better value of organic fertilizers by anaerobic fermentation as compared to that by traditional way, on the aspect of environmental health and their nutrients.

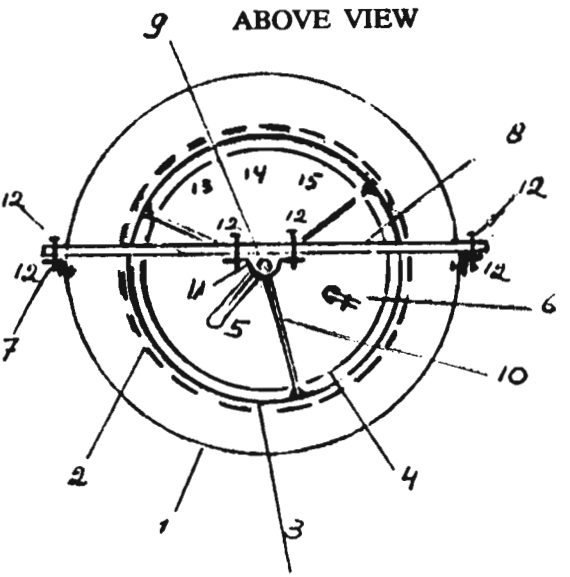
MATERIAL AND METHOD

The study was done at the north of Jakarta where the temperature is suitable for anaerobic fermentation (24-33C). There were 12 digesters of 80 liter capacity placed randomly in three blocks on the purpose of producing organic fertilizers by anaerobic fermentation (Figure 1). In each block there were four kinds of raw materials: chicken drops, pig dung, cow dung and water hyacinth mixed with 15 % cow dung.

The significance of random placement is due to the location of the experiment in which the first block received earlier sunlight as compared to second and third block respectively. The exposure of digester to sunlight will effect the activity of fermentation through the increase of temperature. Next to each digester was a plastic bag inside an 80 liter drum containing organic waste similar to that in each digester, for control where organic fertilizer was made in a traditional way.

Both fermentation, anaerobic and traditional ran for 10 months, by then the process ended. The indicator of this anaerobic fermentation process was the biogass which were still produced by the digesters during that period of time. After 10 months, 12 samples of 9 gram dried materials contained sludge of anaerobic fermentation and 12 samples contained organic fertilizer made in traditional way were taken from 3 replicates of each raw material respectively, and were sent to the laboratory of Tropical Biology (BIOTROP) for nutrient (element), examination (N.P.K), following the method mentioned in the Text book of Quantitative Inorganic Analysis, Including Elementary Instrumental Analysis [4].





Legend:

1. Tank (drum) for water trap
2. Clamp for fermentation tank (drum)
3. Tank (drum) for biogas
4. Fermentation tank (drum)
5. Mixing van
6. Gas valve
7. Supporter of handle for vertical driving pipe
8. Handle for vertical driving pipe
9. Vertical driving pipe
10. Supporter of vertical driving pipe
11. Loose holder of vertical driving pipe
12. Screw-bolt
13. Faeces or waste (fermented)
14. Water
15. Biogas

Figure 1. Small fermentation tank (80 liter) made from used drum, modified from BIOTROP type, which were placed randomly in 3 blocks side by side with the drum for traditional fertilizer.

To evaluate its positive value the traditional method of making fertilizers from wastes and animal drops were used as comparisons. This was performed by preserving the waste and animal drops or dung in plastic bags in equal amount and duration to the raw materials which was used for anaerobic fermentation.

RESULT

Analysis of nutrient (N.P.K) showed that the percentage of nitrogen and phosphate is generally higher in fertilizers made in anaerobic fermentation as compared to fertilizers made in traditional way. But the fertilizers made of water hyacinth mixed whith 15% of cow dung showes a higher percentage of phosphate than that made in the traditional way. Generally, the percentage of potassium in fertilizers made by traditional way was higher, as compared to fertilizers made by an anaerobic fermentation but the percentage of potassium in the fertilizers made by anaerobic fermentation from pig dung is slightly higher compared to that by traditional way (Tabel 1).

Tabel 1. Nutrients (N,P,K) in fertilizers made by anaerobic fermentation and fertilizers made by traditional way (without anaerobic fermentation).

	with anaerobic fermentation			without anaerobic fermentation		
	(%) N	P	K	(%) N	P	K
Chicken drops	2.5704	4.2439	0.6481	1.7350	1.9120	1.1867
Pig dung	2.3455	6.6302	0.6314	1.9921	3.4804	0.5916
Water hyacinth + 15% cow dung	2.5061	1.3041	0.4751	2.4418	3.4804	0.4912
Cow dung	1.8957	2.6786	0.4751	1.8635	2.6786	0.6816

DISCUSSION

Based on the nutrient value (N.P.K), the result shows that sludge of anaerobic fermentation as fertilizers is better than fertilizers made without anaerobic fermentation. The condition of physical composition of traditional organic fertilizers is almost the same with that of raw material, meaning that an anaerobic fermentation can change the nutrient content of fertilizers into a better nutritive value needed by most of the plants, due to its higher nitrogen concentration.

Detailed information to support this idea was given by the United Nations Organization (1984)[5] about the crops which are more or less responsive to fertilizer (effluent) of anaerobic fermentation (Table 2).

Tabel 2. Responsive and Less Responsive Crops to Fertilizers made in Anaerobic Fermentation expected by United Nations (9184).

Responsive	Less Responsive
Vegetable crops especially	Cereal crops
Potatos	Jowar
Tomatos	Bajra
Sweet potatos	Wheat
Water melons	Ragi
Radishes	Barley
Carrots	Oats
Cauliflowers	
Turneps	
Onions	
Garlic, etc	
Fruit trees and vine such as	Oilseed crops
Orange	Groundnuts
Grape	Linseed
Apple	Sesame
Guaya	Castor beans
Mango, etc	Coconut
Other crops including	Other crops including
Sugarcane	Cotton
Rice	
Jute	

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The responsive crops mentioned above are beneficial food for human consumption, as fruits, vegetables or as staple and they contain carbohydrates, minerals, proteins, and sometimes medicines. Besides their usefulness as food, onions and garlic are also known as source of traditional medicine by the people of Jawa and Bali. So, indirectly, this biotechnology of fertilizer production process by anaerobic fermentation can improve the nutrition of the people by increasing the production of crops containing vitamins and other important nutrients.

Like other organic fertilizers such as humus, fertilizer made by anaerobic fermentation will increase the soil porosity and

water holding properties. This condition will support microbiological activity in the ground. A certain kind of microorganism is needed by root of plant to developed well for a long time in the soil, even over a period of more than three years and is known as residual effect[5]. This is one of the purposes of natural conservation. And it is a special benefit of organic fertilizer as compared to chemical fertilizers, which sometimes have a very bad side effect.

Increase amount of nitrogen and phosphate as the result of anaerobic fermentation is not due to the intiltration of these nutrients into the tank (for example from the air) but because they are relatively not much used during anaerobic fermentation, meanwhile carbon is greatly used for generating methane (CH4), followed by the reduction in total weight of the substrate (raw materials). Reduction of total weight and the same content of nitrogen and phosphate causes the increase of percentage nitrogen and phosphate concentration at the end of the process of anaerobic fermentation. The dead microorganism in the fermentation materials are part of nitrogen content in the organic fertilizers.

Pathogenic agent examination showes that *E. coli*, one of indicator for biological pollution, comes to harmless level for environmental health after two months (Seregeg, 1987 unpublished). None of other pathogens including eggs of intestinal parasites could survive after 70 days of anaerobic fermentation[3]. However in the environment, eggs of intestinal parasites, for example, eggs of Ascaris could survive for more than three months (Hariani Marwoto., personal communication).

Murad et.al. (1987)[7] mentioned that several parasites (Nematoda: *Mecistocirrus, Oesophagustomum radiatum* and *Haemonchus placei*) were recognized in the fertilizer of buffalo's drops and animal manure on the floor of its shelter. He also mentioned that people in Bandung (regency in which 13 districts were taken as study areas) are accustomed to using animals drops and animal menure as fertilizers.

Salman Kodijat[8] cited that research conducted by Division of Parasitology, Faculty of Medicine, University of Indonesia mentioned that vegetables (cabbages and salads) in West Java, sold in the market having 8-16 % *Ascaris* eggs (sold in the common market) and 6-12% *Ascaris* eggs for vegetables sold in the super market. Furthermore, he mentioned that since cultivating vegetable needs a lot of water and fertilizers, frequently vegetable plants are fertilized with mud of drain or animal drops.

Base upon these information a strong consideration could be accomplished that in urban areas of West Java, people are accustomed to using raw animal drops (by mean of no special treatment such as anaerobic fermentation) which frequently have several kinds of infectious agent such as parasite eggs and possibly other pathogens. If this accomplishment is matched with the result of anaerobic fermentation revealed that "none of other pathogens including eggs of intestinal parasite could survive after 70 days[3], it means that fertilizers made by anaerobic fermentation after three months is safe and generally free from pathogens. Considering the wide usage of this fertilizers in rural areas and if this recommended method is practised it will improve the health of the poeple.

But to practise this method requires funds and knowledge. For those who are needy and lack knowledge, practising this method is

unlikely to be successful. In this case the government should help them. Regarding the initial investment of this method as compared to that of the traditional way, the public health benefit and the additional value of the biogas outweigh the cost.

In addition, if the farmers are located in remote areas, they have to spend their money regularly for transportation to get fertilizers from nearby towns. If this organic fertilizer is already available in their area (because organic waste are abundant), then expenses for transportation and fertilizers would be eliminated.

ACKNOWLEDGEMENT

To Dr. M. Sudomo and Dra. Hariani Marwoto, the writer wishes to express his gratitude for their beneficial information.

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